ANALYSIS AND RECOMMENDATIONS FOR THE STOCK ASSESSMENT OF SPINY LOBSTERS ON THE COAST OF BRAZIL BASED ON THE REVIEW OF TWO PUBLISHED PAPERS

Raúl E. Lara Mendoza
Technical Consultant to MSC
Fisheries Researcher

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Dr. Raúl E. Lara Mendoza
Technical Consultant for Marine Stewardship Council
raul.e.lara.mendoza@gmail.com

This review and analysis were conducted at the invitation of Centro Desarrollo y Pesca Sustentable (CEDEPESCA), with the aim of providing an objective and quantitative opinion about the stock status of spiny lobsters on the Brazilian coast.

After reviewing two published papers and comparing it with other literature on spiny lobster fisheries in the Caribbean, I would like to bring the following considerations about them to your attention, in order to make some contribution to improve and/or strengthen the stock assessment in Brazil:

The information and stock analysis for these species in Brazil come from the review conducted by Cruz & Bertelsen (2008) and Cruz *et al.* (2020). It is unknown from those papers whether the reconstruction of the historical catch series by species considered the different sources of fishing mortality. For stock assessment, it will always be necessary to consider extraction sources or catches that are not reported; unreported catches (or at least an estimated percentage) should be taken into account.

The papers do not document, or provides only very basic information on, studies about the spatial distribution of catches for each spiny lobster stock along the Brazilian coast. This aspect is crucial to explore during stock assessments and the implementation of management measures, taking into account the distinct characteristics of the region, fishing fleets, and each possible individual stock.

In the Kobe Diagram (Fig. 4), the confidence intervals are too large, to the point that the status of the spiny lobster in the last evaluated year could fall into any of the quadrants of the phase or Kobe diagram. One way to reduce the uncertainty in the estimates is by including an indicator of relative abundance throughout the catch time series, which will help the model converge in conjunction with the catch data and the resilience of the lobster population.

Its not clear from the publication, especially in the methodology, whether the reconstruction included all species together or separately. Ideally, stock assessments should be conducted by reconstructing the historical catch series for each stock, as their biological and fishing exploitation conditions will influence the health of their populations. It would be expected that, at the very least, separate evaluations be conducted for the spiny red lobster (*P. argus*) and the green lobster (*P. laevicauda*), as these are the most abundant species in Brazil's catches.

Currently, limitations of the CPUE abundance index continues to add uncertainty to the stock estimates, further work is required to make it a reliable index to correctly interpret the stock assessment model for the spiny lobsters. Therefore, its necessary to incorporate an abundance index (e.g., nominal CPUE) into the CMSY assessment model to reduce the uncertainty and the intervals for the last year.

The papers recognize and indicated that due to the wide variety of fishing gears, methods, and boats makes it difficult to study and monitor lobster fisheries and to standardize the catch per unit of effort (CPUE). However, the standardisation of CPUE is the most important and key aspect in the stock assessment for fisheries resources. For example, the Bahamas spiny lobster fishery (Matthews & O´Kane, 2021) is certified by the Marine Stewardship Council (MSC) and one of the most important principles for its certification is to determine the stock status with great precision, where the incorporation of standardized CPUE played a significant role in improving the performance of the model used (age/sized structured model) (Bystrom *et al.,* 2022; you can see more details in https://fisheries.msc.org/fisheries). The same technical recommendations have been reported for the Mexico Baja California red rock lobster (*Panulirus interruptus*) a certified fishery where have been used the Schaefer model (1954) contrasting the catch data and CPUE as a relative index of abundance, and for this reason de CPUE index is a very important aspect to consider in the future stock assessment in the Brazilian lobster fisheries.

There is a significant inconsistency in the results presented in the study, stemming from the review of stock assessment studies on spiny lobsters in Brazil. On one hand, the results derived from the use of the Monte Carlo model (CMSY) to estimate fishery reference points based on annual landings, and on the other hand, biological indicators suggest that the stock may not be in healthy condition, because a large percentage of immature individuals are being captured, as noted in the externalities in this paper. Additionally, it is reported in the paper that the artisanal lobster fleet operates in shallow waters where pre-recruits represent between 15% (May) and 18% (June) of the population, which has been shown to significantly affect various biological processes (recruitment and eventually the density of reproductive adults), as well as future catches and yield. Therefore, stock status assessed using catch-based methods could be underestimating these important considerations for evaluation and management. For this reason, it is very important that future research focused on the assessment of spiny lobster stocks considers exploring evaluations through size-based biological reference points and other life history parameters or exploring the Bayesian state-space surplus production models (Konoyima *et al.,* 2024).

For the reasons mentioned above and the recommendations issued for other certified lobster fisheries or those undergoing pre-assessments for fishery improvement projects in other countries, it is not recommended to use this type of method for data-limited fisheries based solely on catch, such as the CMSY approach. In this context, biological information such as recruitment, growth, average size-at-maturity, fecundity, and size structure over time is more useful for determining

stock status through size/age-structured models like (VPA/ADAPT and Statistical Catch at Age Analysis).

CONCLUSIONS

There is a wide range of biological, fishery, commercial, and environmental information scattered about lobster stocks in Brazil. Although this information is fragmented, it could be collected and integrated to perform a more robust stock assessment. Additionally, some parameters and information will need to be improved or gathered.

The CMSY approach used to assess the lobster stocks in Brazil may not be the most appropriate model for assessment these species, as it only considers and heavily weights information from the catch data, assuming therefore that effort is constant along a large period. This is evident in the results and the Kobe plot, which show the stocks in a recovered condition, even in a healthy stock state (green quadrant). However, the size data suggests otherwise, as many individuals are being captured below the documented mean maturity size for the region. Therefore, it is necessary to explore the use of methods based on biological information as size/age-structured models or, alternatively, models that incorporate the use of some abundance index like CPUE, or, in the best-case scenario, integrative models like Stock Synthesis (SS3), which incorporate all existing information about the stocks.

TECHNICAL RECOMMENDATIONS

After reviewing the several papers and comparing with spiny lobster stock assessments from other regions of the world, the following recommendations are issued:

- It is highly recommended to assess the stocks of green and red lobster separately, as each species exhibits slightly different life history traits, spatial distribution, and other bioecological aspects that must be taken into account. Combining the two species into a single stock assessment is not advisable.

- Explore the estimation of indicators based on sizes and basic biological parameters of spiny lobsters in the region like size/age-structured models. This approach may yield different results compared to catch-based-methods and population resilience.

- Consider incorporating spatial analysis of catches in future assessments, as the map presented in the paper clearly shows that the green lobster catch is more concentrated along the central-southern coast of Brazil. This has significant

implications for stock assessment and regional management. Additionally, this approach will allow for a better understanding of abundance indices in the future.

- Continue efforts to standardize abundance indices such as catch per unit of effort (CPUE) or other fishery-independent indicators. These indices will be useful for more complex and comprehensive models and should cover the longest possible time series. Standardization should be performed by species, exploring various spatial, temporal, gear-specific, and fishing method-related strategies and hypotheses, as well as the type of probability distribution for each variable, among other factors.

- Given the availability of historical catch data by species, size structure information, life-history parameters, age and growth studies, conversion factors, some relative abundance indicators, and some fishery-independent indicators, it is possible to explore stock assessments using integrated models such as Stock Synthesis (SS3).

REFERENCES

Bystrom, A., Jurado-Molina, J. & Rivera, S. 2022. Mexico Baja California Red Rock Lobster: MSC Fishery 3rd Reassessment Report. Final Draft Report. SCS Global Services Report. 265 pp.

Cruz, R., Santana, J.V.M., Barret, B., Borda, C.A., Torres, M.T., Gaeta, J.C., Da Silva, J.L.S., Saraiva, S.Z.R., Salazar, I.O. & Cintra, I.H.A. 2020. Towards the rebuilding of spiny lobster stocks in Brazil: a review. *Crustaceana.* 93(8): 957-983.

Cruz, R. & Bertelsen, R.D. 2008. The Spiny Lobster (*Panulirus argus*) in the Wider Caribbean: A Review of Life Cycle Dynamics and Implications for Responsible Fisheries Management. Proceedings of the 61st Gulf and Caribbean Fisheries Institute. 433-446.

Konoyima, K.J., Mansaray, A. & Zhu, J. 2024. Stock assessment using Bayesian state-space surplus production models: the case of bonga shad, *Ethmalosa fimbriata* (Bowdich, 1825), in the Eastern Central Atlantic Ocean. *Research Square* [https://doi.org/10.21203/rs.3.rs-3976513/v1]

Matthews, T. & O´Kane, B. 2021. The Bahamas Spiny Lobsters Fishery. Marine Stewardship Council (MSC) 2nd Surveliance Audit. Control Union (UK) Limited. 47 pp.

Morison, A.S. & Brand-Gardner, S. 2022. Australian western rock lobster fishery. Final Draft Report. Marine Stewardship Council Fisheries Assessment. 193 pp.